Project Number:	651
Category:	Design/Construction of Fixed Bottom Turbines
Date:	January 2009
Subject:	Evaluate the Effect of Turbine Period of Vibration Requirements on Structural Design Parameters
Performing Activity:	Applied Physical Science Corp.
Principal Investigator:	M. Pollack
Contracting Agency:	Bureau of Safety and Environmental Enforcement
Summary:	This effort was primarily an analytical study of resonance coincidence and its impact on the structural design characteristics of offshore wind turbines. It tapped classical methods of fluid dynamics, structural dynamics, and mechanics of materials to assess methods of preventing resonance coincidence and minimizing its consequences. It also assessed the accelerated fatigue that would result from resonance coincidence, using first order estimates of the load encountered by the wind turbine.
Key Findings:	• The current design practice is to design an OWT support structure such that the tower fundamental resonance does not coincide with the fundamental rotational (1P) and blade passing (3P for three-bladed turbines) frequencies of the rotor. This resonance avoidance approach has significant consequences for the structural design of offshore wind turbines and can result in wind turbines with large diameter piles. • Ambient load sources, such as wind gusts and ocean wave loading, are extremely important contributors to the fatigue damage of OWTs, as they are processes with energy at critical support structure natural frequencies (1P and 3P). Therefore, properly characterizing wind and wave climate at potential sites is extremely important when performing s fatigue life assessment during the design of the offshore wind turbines. • Aerodynamic damping, an effect that mitigates blade and global support structure vibrations, is a dominant dissipative mechanism for the fundamental support structure bending mode in offshore wind turbine systems, reduces vibration levels, and increases fatigue life. The effectiveness of the aerodynamic damping is maximized with light nacelles and turbines and/or by designing the wind turbine system to be soft. Aerodynamic damping effect is significantly diminished in parked operation. • Floating systems and jacketed foundations have a different set of period of vibration requirements, compared to traditional pile-mounted systems. In particular, floating systems have an additional set of resonances associated with the rigid body seakeeping modes of the floating platform that must be considered

	in the design process.
Recommendations:	• Additional research is needed to thoroughly validate the suite of wind-turbine-related computational models and tools, such as the Fatigue, Aerodynamics, Structures, Turbulence (FAST) suite of programs. • Period of vibration requirements for floating turbines or jacketed foundations should be further investigated.
Subsequent Studies/Activities:	• TAP 669: *Floating Wind Turbines* • TAP 670: *Design Standards for Offshore Wind Farms*
Report Link:	AA